

NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD

Well (No.) No. 642

Definition

A well constructed or improved to provide water for irrigation, livestock, wildlife, or recreation.

Purpose

To facilitate proper use of vegetation on rangeland, pastures, and wildlife areas; to supply the water requirements of livestock and wildlife; to provide an adequate supply of water for conservation irrigation; and to provide for human use at recreation sites.

Conditions Where Practice Applies

All irrigation wells shall be planned and located to serve as a source of water for an irrigation water distribution or conveyance system designed to facilitate the conservation use of the soil and water resources on a farm or group of farms.

Irrigation wells are limited to geological sites where sufficiently large volumes of underground water are available at a rate that will permit practical irrigation of the land on which the water is to be used. Wells may be the only source of water or they may supplement other sources. The land on which the water is to be used must be suitable for the production of locally adapted crops grown under irrigation farming. The water must be of adequate quality to insure that it will not materially reduce the productive capacity of the soil on which it is to be used.

Wells are applicable on rangeland, pastures, cropland, and wildlife and recreation areas where present water facilities are inadequate and the underground water supply is adequate in quantity and quality for the purpose to be served and can be developed at an economical cost.

Federal, State, and Local Laws¹

Design and construction activities shall comply with all federal, state, and local laws, rules, and regulations governing pollution abatement, health, and safety. The owner or operator shall be responsible for securing all required permits or approvals and for performing in accordance with such laws and regulations. NRCS employees are not to assume responsibility for procuring these permits, rights, or approvals, or for enforcing laws and regulations. NRCS may provide the landowner or operator with technical information needed to obtain the required rights or approvals to construct, operate, and maintain the practice.

There are specific WV requirements for wells issued by the WV Department of Health.

Permits may be required from the following agencies:

- 1. West Virginia Department of Health*
- 2. West Virginia Department of Agriculture*

Planning Considerations

Water Quantity

1. Effects the cone of depression, formed by pumping the well, has on adjacent water uses and users.

2. Balance of water removed from the aquifer versus its available recharge to estimate the life and utility of the well.

Water Quality

1. Effects of well discharge on surrounding surface and ground water quality.

2. Methods and procedures used in the construction, development, operation, and maintenance of the well that could prevent damage to surface or ground water quality.

Design Criteria

General. The suitability of the well site and the type of well installed shall be based on detailed geologic investigations, including test well drillings, on ground-water assessment studies made by local, state, or federal agencies, or on reliable local experience. The design should include ground-water conservation measures, provisions for controlling contamination from one aquifer to another in the well, and methods for obtaining a maximum supply of sediment-free water.

Well diameter. The diameter of the well shall be adequate to meet the yield capacity of the formation in relation to the nature and extent of the water-bearing area and to permit the installation of a pump to deliver the needed amount of water to the projected lift elevation.

Casing and materials. Wells shall be cased, but the lower sections passing through consolidated strata do not require casing. Materials shall meet the requirements detailed under "Plans and Specifications."

The maximum depth for well casings shall be based on critical collapse pressure as calculated by the Cleideinst Equation in ASTM-F-480, appendix X2. Depth, as used in this standard, applies to the difference in static head between the inside and outside of the casing. This can be determined by measuring the static head or by using the total depth of the well.

Table 1 gives the depth limitations for polyvinyl chloride (PVC) acrylonitrile-butadiene-styrene (ABS), and styrene-rubber (SR) well casing pipes having different standard dimensions ratios and moduli of elasticity.

Table 1.—Maximum depth of installation for plastic (SDR-PR) pipe

SDR	Material			
	PVC	ABS	SR	
	Modulus of elasticity (E)			
	400,000	320,000	250,000	300,000
13.5	985	785	615	735
17	475	380	295	355
21	245	200	150	185
26	130	100	80	95
32.5	65	50	40	50

Table 2 gives the dimensions and maximum depth of installation for PVC Schedules 40 and 80 pipe constructed of material having a modulus of elasticity equal to 400,000 lb/in². The factors given at the bottom of this table may be used in calculating depth limitations for ABS Schedules 40 and 80 pipe and other PVC classifications.

Figure 1 can be used in determining the maximum depth of plastic and fiberglass casings not covered by Tables 1 and 2.

Table 3 gives the dimensions and maximum depth of installation for reinforced plastic mortar (RPM) well casings of various sizes and wall thickness.

Concrete water well casings shall be limited to wells not greater than 500 feet in depth.

Table 4 gives the minimum allowable thickness of metal casings. Table 5 gives the maximum depth of installation for steel casings.

Casings having a different wall thickness can be used in the same well if the maximum allowable depth for each is maintained.

Screens. All wells constructed to recover water from unconsolidated aquifers shall be

Table 2.—Dimensions and maximum depth of installation for Schedules 40 and 80 PVC plastic pipe

Nominal diameter	Outside diameter	Schedule 40			Schedule 80		
		Minimum wall thickness	SDR	Maximum depth	Minimum wall thickness	SDR	Maximum depth
<i>in.</i>	<i>in.</i>	<i>in.</i>		<i>ft</i>	<i>in.</i>		<i>ft</i>
2	2.375	0.154	15.4	650	0.218	10.9	1,960
2½	2.875	.203	14.2	840	.276	10.4	2,260
3	3.50	.216	16.2	550	.30	11.7	1,550
3½	4.00	.226	17.7	420	.318	12.6	1,220
4	4.50	.237	19.0	340	.337	13.4	1,010
5	5.563	.258	21.6	230	.375	14.8	740
6	6.625	.280	23.7	170	.432	15.3	660
8	8.625	.322	26.8	120	.50	17.3	450
10	10.75	.365	29.5	90	.593	18.1	390
12	12.75	.406	31.4	—	.687	18.6	360

NOTE: Tables for PVC Schedule pipe made of material having a modulus of elasticity of 400,000 lb/in.². For PVC pipe having a modulus of elasticity of 360,000, multiply the depths by a factor of 0.9. For PVC pipe having a modulus of elasticity of 320,000, use a factor of 0.8. A factor of 0.625 can be used for ABS Schedules 40 and 80 pipe having a modulus of elasticity of 250,000 lb/in.²

Table 3.—Dimensions and depth limitations for reinforced plastic well casings

Diameter	Maximum depth <i>in.</i>								
	20	60	100	200	300	400	500	750	1,000
	Minimum wall thickness <i>in.</i>								
8	0.17	0.17	0.23	0.23	0.23	0.29	0.29	0.33	0.33
10	.17	.17	.28	.28	.28	.36	.36	.41	.41
12	.18	.19	.34	.34	.34	.43	.43	.46	.46
14	.19	.22	.32	.40	.40	.43	.46	.46	.46
15	.19	.24	.34	.34	.46	.46	.46	.46	.46
16	.20	.25	.36	.36	.46	.46	.46	.46	.46
18	.21	.28	.40	.40	.45	.45	.45	.52	.52
20	.21	.31	.42	.42	.45	.45	.45	.54	.54
21	.21	.33	.48	.48	.48	.48	.48	.57	.57
24	.24	.38	.48	.48	.57	.57	.57	.57	.57
27	.26	.40	.49	.49	.49	.62	.62	.62	.62
30	.29	.44	.49	.49	.49	.68	.68	.68	.68
33	.32	.44	.60	.60	.60	.75	.75	.75	.75
36	.35	.48	.65	.65	.65	.82	.82	.82	.82

equipped with manufactured screen sections, well points, or field perforated sections meeting the criteria stated below. The screen openings for aquifer material of near uniform size shall be smaller than the average diameter of the aquifer material. The screen or slotted casing section must be protected with a device immediately above the intake section if necessary to prevent well stabilizer materials from entering the intake section area.

For graded aquifer materials (of nonuniform gradation), the screen shall be sized so that 25 to 40 percent of the aquifer material is larger than the screen opening. For wells in which a gravel pack envelope is used, the screen shall have openings that will exclude at least 85

percent of the gravel pack material. The length and open area of the screen shall be adequate to maintain the entrance velocity of water into the well at an acceptable level, preferably less than 1/10 ft/s.

The position of the screen in the well shall be governed by the depth of the aquifer below the ground surface and the thickness of the aquifer to be penetrated by the well. If practical, the top elevation of the screen shall be below the lowest water level expected during pumping and be located opposite the most permeable area in the water-bearing strata.

Filter pack. Sand or gravel filter packs shall be used in wells constructed in fine material of relatively uniform grain size to prevent the aquifer materials from passing through the well screen or the perforated casing. The pack shall be 3 to 12 inch thick and shall consist of sand or gravel material having a D_{30} grain size 4 to 12 times the D_{30} grain size of the aquifer material. Provisions shall be made for centering the casing in the filter pack.

Table 4.—Minimum thickness of metal casings for wells

Diameter	Minimum wall thickness	
	Steel casing	Lightweight galvanized casing ¹
in.	in.	in.
1	0.133	—
1½	.145	—
2	.154	—
2½	.203	—
3	.216	—
3½	.226	—
4	.060	.0322
4½	.060	.0322
5	.075	.0382
6	.105	.0382
8	.105	.0486
10	.105	.0486

¹Lightweight galvanized casings shall be used only in areas where local experience has proved them to be satisfactory.

²For driven or drilled wells.

Sanitary protection. Wells shall be located a safe distance from sources of contamination. If sources are severely limited, a ground-water aquifer that might become contaminated can be used as a water supply for human consumption if adequately treated. Details pertaining to local water wells, such as depth, type of construction, and vertical zone of influence, together with data on the geological formations and porosity of subsoil strata, shall be considered in determining the safe allowable distances. The recommended minimum horizontal distance between the water supply and the source of contamination is:

Source of Contamination	Minimum Distance ft
Waste disposal lagoon.....	300
Cesspool.....	150
Livestock & poultry yards.....	100
Privy, manure pile.....	100
Silo pit, seepage pit.....	150
Septic tank & disposal field.....	100
Gravity sewer or drain (not pressure tight).....	50
Gravity sewer or drain (pressure tight).....	25

If possible, wells shall be located in ground that is higher than any source of contamination or flooding. Drainage that might reach the source from areas used by livestock shall be diverted. Wells must be readily accessible for maintenance and repair and be located a safe distance from overhead utility lines or other safety hazards. Each well shall be provided with a watertight cover or seal to prevent the entry of contaminated water or other objectionable materials. The annular space around the casing shall be at least 3 inch and shall be filled with cement grout, bentonite clay, or other suitable materials to a depth that will seal off surface waters. A positive seal shall be provided between the casing and the impervious material overlying the aquifer of artesian wells.

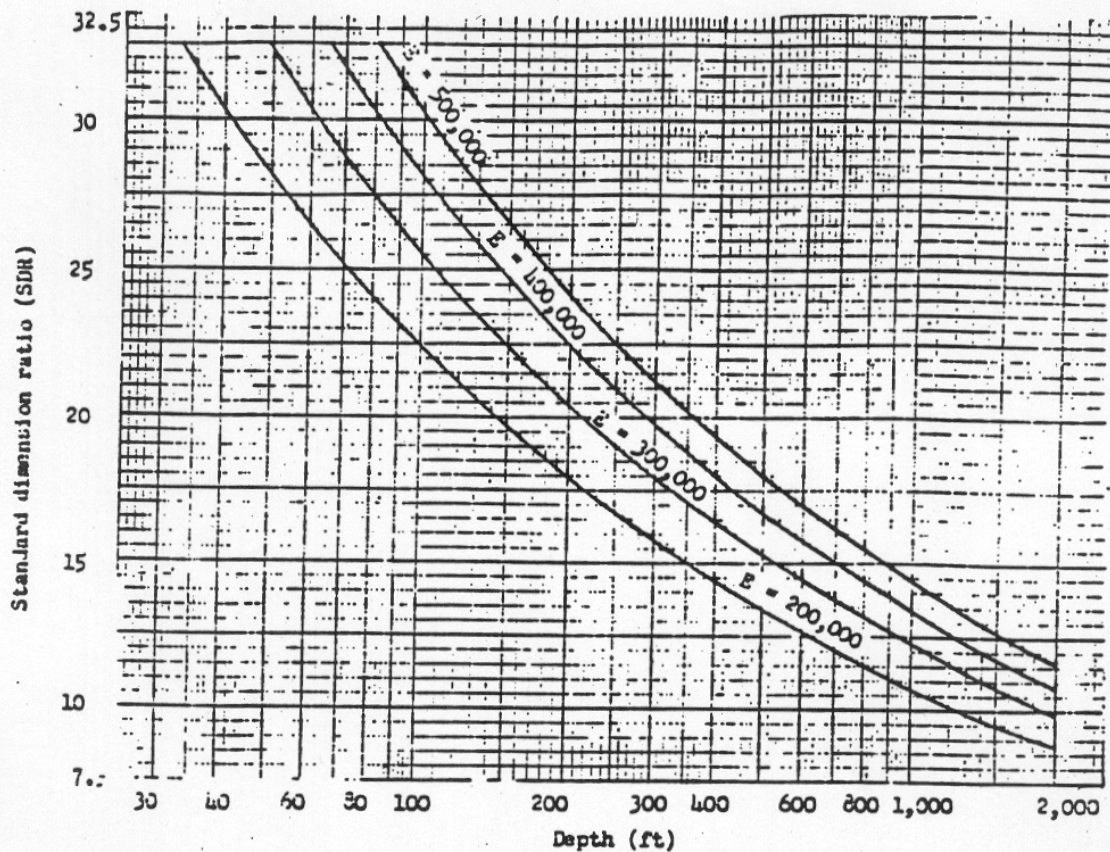


Figure 1.—Maximum depth of installation for plastic (SDR-PR) pipe.

Table 5.—Maximum depth of installation for steel casings

Wall (uncoated) thickness	Casing size (in.)									
	4	5	6	8	10	12	14	16	18	24
	Outside diameter (in.)									
	4.500	5.563	6.625	8.625	10.750	12.75	14.00	16.00	18.00	24.00
20 Ga (0.036)	80	40	25	—	—	—	—	—	—	—
18 Ga (0.048)	180	100	50	25	—	—	—	—	—	—
16 Ga (0.060)	370	190	110	50	25	—	—	—	—	—
14 Ga (0.075)	720	380	220	100	50	30	20	—	—	—
12 Ga (0.105)	2,030	1,060	620	280	140	80	60	40	—	—
10 Ga (0.135)	—	—	1,340	600	310	180	130	90	60	—
8 Ga (0.164)	—	—	—	1,080	550	330	250	160	110	—
7 Ga (0.179)	—	—	—	1,410	720	430	320	210	150	—
3/16 (0.188)	—	—	—	1,650	840	500	370	250	170	70
7/32 (0.219)	—	—	—	—	1,340	800	600	400	280	110
1/4 (0.250)	—	—	—	—	—	1,190	890	600	420	170
9/32 (0.281)	—	—	—	—	—	—	1,280	850	590	250
5/16 (0.312)	—	—	—	—	—	—	—	1,170	820	340
11/32 (0.344)	—	—	—	—	—	—	—	—	1,100	460
3/8 (0.375)	—	—	—	—	—	—	—	—	—	600
7/16 (0.438)	—	—	—	—	—	—	—	—	—	960

NOTE: Based on the Glendwest Equation for Critical Collapse Pressure, using Poisson's ratio (ν) of 0.30 and a modulus of elasticity (E) of 30,000,000 lb/in².

$$D = \frac{2E}{1-\nu^2} \times \frac{2.31}{\text{SDR}(\text{SDR}-1)^2}$$

Plans and Specifications

Plans and specifications for wells shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

Alignment

Drilled vertical wells shall be round, plumb, and aligned to permit satisfactory installation and operation of a pump of the proposed size and type to the greatest anticipated depth of setting.

Casings

Materials. Casings can be made of steel, copper, plastic, fiberglass, concrete, or other materials of equivalent strength and durability.

Steel, copper, reinforced plastic mortar, plastic, or fiberglass pipe casings can be used in drilled wells. Only steel pipe casings shall be used in driven wells. If the water is to be used for human consumption, plastic casings for transporting potable water supplies must be approved by the National Sanitation Foundation. Used steel pipe can be used for well casings if it is of good quality and has a wall thickness equal to or greater than that of Schedule 40 pipe.

Plastic casings shall be made of acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) and shall conform to the requirements specified in ASTM-F-480. Plastic pipe manufactured for water or irrigation pipelines can be used if the quality of the pipe equals or exceeds that specified in ASTM-F-480.

Fiberglass casings can be used if tests indicate that:

1. The material meets the requirements specified in ASTM-D-2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM-D-2996 are not needed because the pipe is to be used for well casing.
2. The joints meet the requirements specified in ASTM-F-480.
3. The modulus of elasticity is certified for use in determining maximum depth.

Concrete casings shall be reinforced and shall meet or exceed the requirements specified in ASTM-C-76. The minimum 28-day compressive strength shall be 4,000 lb/in².

Reinforced plastic mortar casings shall equal or exceed the requirements specified in ASTM-D-3517.

Steel well casings shall equal or exceed the requirements specified in ASTM-A-589. Steel pipe manufactured for other purposes can be used if the quality of the pipe equals or exceeds that specified in ASTM-A-589.

Joints. Joints for well casings shall have adequate strength to carry the load due to the casing length and still be watertight or shall be mechanically supported during installation to maintain joint integrity. Such mechanically supported casings shall terminate on firm material that can adequately support the casing.

Gravel pack. If gravel packing is used, it shall have the gradation and thickness specified in the design and shall be carefully placed to prevent segregation and bridging. Gravel pack material shall extend a minimum of 10 feet above the top of the perforated or screened section and shall extend through the length of the water-bearing formation.

Installation. In consolidated formations, the casing shall extend from the ground surface through the overburden material to an elevation of at least 2 feet into the consolidated material.

In unconsolidated formations, the casing shall extend from the ground to the screen.

For artesian aquifers, the casing shall be sealed into the overlying impermeable formations to retain the artesian pressure.

If a water-bearing formation known to contain or suspected of containing poor-quality water is penetrated, the formation shall be sealed to prevent infiltration of poor-quality water into the well and the developed aquifer.

Developing

The well shall be developed until it stops producing detrimental quantities of solid particles when the continuous discharge rate is

approximately 20 percent greater than the anticipated normal production rate.

Protection

All wells shall be cased to a sufficient height above the ground surface to prevent the entry of surface and near-surface water.

If the well water is for human consumption, the annular space outside the casing must be filled with a watertight cement grout or clay having similar sealing properties from the surface to a minimum of 10 feet below the ground surface. The casing shall be surrounded at the ground surface by a 4-inch concrete slab extending at least 2 feet in all directions. A sanitary well seal shall be installed at the top of the well casing to prevent the entry of contaminated water or other objectionable materials.

Workmanship

The well casing pipe, couplings, and screens shall be homogeneous throughout and shall be free of visible cracks, holes, foreign materials, or other injurious defects. The well casing pipe, couplings, and screens shall be as uniform in color, density, and other physical properties as is commercially possible.

Markings

The well casing pipe shall be marked according to the ASTM specification for the material used.

Certification

Markings on material identifying the manufacturer and indicating compliance with appropriate specifications can be accepted as evidence that the material meets the requirements of this standard. If the material does not bear these markings, the manufacturer can certify that it complies with the requirements of this standard. The State Conservation Engineer, however, can request tests supporting this certification.

Operation and Maintenance

An operation and maintenance plan shall be developed. The well shall be inspected periodically to insure its proper function. The area around the well shall be inspected and repaired as necessary to insure that surface water is excluded.

¹***Bold italics is information added to the National standard by West Virginia.***